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PHOTOGRAPHY.

Photography means writing or delineating by light. It is derived from two Greek words, *phos*, light, and *grapho*, I write. Some have argued that this word does not accurately express the nature of the art it is intended to designate; that the term would be applicable if the whole of a ray of light acted to produce the effect; but as the researches of science have shown that only one part of the sun's rays is called into action in the exercise of the art, it would have been preferable to have employed the term heliography, written or delineated by the sun. This word was first employed by M. Niepce, one of the original discoverers of the process; but the employment of the term photography has been sanctioned by use, and is now universally received and adopted.

Photography is certainly one of the most important discoveries of our age. In relation to physics and chemistry, it has already been the means of elucidating many points which had not been investigated, or which were but imperfectly understood. In reference to optics especially it opens a large field of research and discovery. Had Newton been acquainted with the properties of light which are developed in the phenomena of photography, there is no doubt that he would have left a more complete theory of light, and of the various rays which compose it. *

Light, if admitted through a small hole in the shutter of a darkened room, will form a white spot on the place on which it falls. If a triangular prism of glass be placed on the inside of the shutter, so that the beam of light must pass through it, on leaving the glass it no longer retains its old characteristics, but forms an oblong painted image of seven colours,—red, orange, yellow, green, blue, indigo, and violet. This is called the solar spectrum. Sir Isaac Newton was the discoverer of this important fact. The experiment is easily made and easily understood. White light is a bundle of coloured rays united together. In passing through the prism the bond of union is severed, and the coloured rays assume an independent and separate character. Seven colours being observed in the spectrum, many believed, and Newton among the rest, that there were seven rays of coloured light. This was a mistake. Sir David Brewster, in his experiments, proved that these seven colours were occasioned by three primary rays; namely, the red, the yellow, and the blue. These rays are concentrated when each primary colour appears most vivid, but each spreads more or less over the others, the mixture of red and yellow giving orange; of yellow and blue, green; of red and blue, violet.

The experiments of Dr. Herschell have established the fact, that each ray of light does not contribute its proportionate share to the intensity of the heat which is produced by the concentration of the sun's rays in the focus of a burning-glass. Formerly it was imagined that each ray communicated the same heat; the advance of science has taught us that this theory is fallacious. Dr. Herschell says, that in a variety of experiments which he occasionally made relating to the method of viewing the sun with large telescopes to the best advantage, he used various combinations of differently coloured darkening glasses. What appeared remarkable was, that when he used some of them, he felt a sensation of heat, though he had but little light—whilst others gave him much light with scarcely any heat. Now, as in these combinations the sun's image was always differently coloured, it occurred to him that the prismatic rays might have the power of heating bodies very unequally among them. The experiments which he made consisted of passing each ray through an opening in a piece of pasteboard, and placing delicate thermometers, with blackened balls, so that they could be irradiated with each particular colour. The result of these investigations proved, that the red rays possessed a greater amount of heating power than those of any other colour; that the violet rays communicated the least.

Previous to these investigations it was known that light produced a blackening influence on paper moistened with a colourless solution of nitrate of silver, and the discovery of Herschell brought about the inquiry, whether the greatest amount of chemical effect took place at the violet end of the spectrum, where the heating power is least, or at the red where the heat is greatest. From the investigations and experiments thus suggested, it became evident that light was composed of three distinct properties, producing heating, chemical, and luminous effects.

Strange it seems that light, so common and so universal, should have been for so long a period so imperfectly understood that even now it is only partially comprehended. "An agent influencing every form of animate and inanimate creation would necessarily excite the attention of the earliest races," but all that the untutored mind could recognise was something mysterious and divine, and that principle which renovated all things was to them the impersonation of a God; and light became the earliest object of idolatrous adoration. The ancient philosophers gave but little attention to natural science. The story of the heating mirrors of Archimedes would seem to imply that he had paid some regard to the properties of light, but what it was in its nature, and what it could effect by those properties, was still left in uncertainty. There was an old notion that certain objects possessed the property of emitting light in the darkness. Benvenuto Cellini says, that he has seen the carbuncle glowing like a coal with its own light. Alchemists, with their strange wild dreams of transmuting baser metals into pure virgin gold, began to direct their attention to the influence of the sun's rays. With them we have the first indication of anything like photographic experiment, and to them we owe many important observations and great discoveries.

The transmuting stone, which formed the foundation of our modern chemistry, succeeded in uniting silver with a marine salt, and produced a combination commonly called *lune*, or argent corne. The salt produced by the alchemists possessed the remarkable property of turning black, and the blackness was vivid just in proportion as the rays which occasioned it were powerful. They knew that if they covered a sheet of paper with a coating of argent corne, or, as it is now called, chloride of silver, and obtained by a lens the form of some object upon the coating, the parts occupied by the figure would change to a dark colour while the other portions continued white. But still, with all this, the minds of the alchemists were too abstract to reduce their discovery to any practical purpose.

About two centuries ago, Giovanni Baptiste Porta, a Neapolitan physician, discovered that if light were admitted through a small circular aperture into a closely-shut room, all the objects without, from which reflected rays reached the hole, would be painted on the opposite wall in strength and size according to their distance, with their forms and relative situations as in an extended picture, with the most precise exactness. Here we have the origin of the camera obscura.

In 1722, it was found that solutions of saltpetre and sal ammoniac crystallized more readily when exposed to the influence of light, than they did in the darkness. Charles William Scheele, of Stralsund, in Swedish Pomerania, discovered that the chloride of silver spread on paper, was speedily darkened in the blue rays, and that the red rays produced but little effect upon it.

Still later experiments made by Mr. Seebeck disclosed the fact that a coloured impression of the solar spectrum was made upon paper spread with muriate of silver. Dr. Wollaston obtained the same results. M. Charles, a Frenchman, succeeded in obtaining black profiles by the action of light, but he never made known the nature of his process, and his secret died with him. The first authentic information respecting the new art was furnished by Mr. Wedgewood, the celebrated porcelain manufacturer, who, in June, 1802, published, in the Journals of the Royal Institution, "An account of a method of copying paintings upon glass, and of making profiles by the agency of light, upon nitrate of silver; with observations by H. Davy."

The account of Mr. Wedgewood's investigation is remarkably interesting, especially as it is the first systematic effort to obtain photographic pictures. The following remarks occur in his memoir: "White paper or white leather, moistened with a solution of nitrate of silver, undergoes no change when kept in a dark place; but on being exposed to the daylight it speedily changes colour, and after passing through different shades of grey or brown, becomes at length nearly black. The alterations of colour take place more speedily in proportion as the light is more intense. In the direct beams of the sun, two or three minutes are sufficient to produce the full effect; in the shade several hours are required, and light transmitted through different coloured glasses acts upon it with different degrees of intensity. Thus it is found that red rays, or the common sunbeams passed through red glass, have very little action upon it; yellow and green are more efficacious; but blue and violet light produces the most decided and powerful effects."

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* Claudet.

Again, "when the shadow of any figure is thrown upon the prepared surface, the part concealed by it remains white, and the other parts speedily become dark. For copying paintings on glass, the solution should be applied on leather, and in this case it is more readily acted on than when applied on paper. After the colour has been once fixed on the leather or paper, it cannot be removed by the application of water, or water and soap, and it is in a high degree permanent. The copy of a painting or a profile, immediately after being taken, must be kept in an obscure place; it may indeed be examined in the shade, but in this case the exposure should be only for a few minutes; by the light of candles or lamps, as commonly employed, it is not sensibly affected. No attempts that have been made to prevent the uncoloured parts of the copy or profile from being acted upon by light have as yet been successful. They have been covered with a thin coating of fine varnish, but this has not destroyed their susceptibility of being coloured; and even after repeated washings, enough of the active part of the saline matter will still adhere to the white parts of the leather or paper to cause them to become dark when exposed to the rays of the sun. Besides the application of this method of copying that has just been mentioned, there are many others; and it will be useful for making delineations of all such objects as are possessed of a texture partly opaque and partly transparent. The woody fibres of leaves and the wings of insects may be pretty accurately represented by means of it, and in this case it is only necessary to cause the direct solar light to pass through them, and to receive the shadows upon prepared leather. "The images," says Davy, "formed by means of a camera obscura have been found too faint to produce in any moderate time an effect upon the nitrate of silver. To copy these images was the first object of Mr. Wedgewood in his researches on the subject, and for this purpose he first used the nitrate of silver, which was mentioned to him by a friend as a substance very sensible; but all his numerous experiments, as to their primary end, proved unsuccessful. In following these processes I have found that the images of small objects produced by means of the solar microscope may be copied without difficulty on prepared paper. This will probably be a useful application of the method; that it may be employed successfully, however, it is necessary that the paper be placed at but a small distance from the lens."

"In comparing the effects produced by light upon muriate of silver with those produced upon the nitrate, it seemed evident that the muriate was the more susceptible, and both were more readily acted upon when moist than when dry—a fact long ago known. Even in the twilight the colour of moist muriate of silver, spread upon paper, slowly changed from white to faint violet; though, under similar circumstances, no immediate alteration was produced upon the nitrate. . . . . . Nothing but a method of preventing the unshaded parts of the delineation from being coloured by exposure to the day, is wanting to render this process as useful as it is elegant."

After these imperfect and comparatively insignificant results, nothing was attempted until the researches of MM. Niepce and Daguerre. M. Niepce was a retired man of business, residing in the neighbourhood of Chalons sur Saône. He devoted much of his time to scientific inquiry, and especially to photographic experiments. His first connexion with M. Daguerre took place in the month of January, 1826. This latter gentleman had for a long time been engaged in similar experiments, and had already so far accomplished his object, as to have now only to fix the images of his design in the dark chamber to make his plan perfect.

When M. Niepce visited England in the following year, he presented a paper on the subject of photography to the Royal Society of London, together with several pictures on metal plates. In 1829, he communicated with M. Daguerre, and they entered into an agreement to pursue for their mutual benefit the researches in which they were both so deeply interested. The registered deed of partnership is dated 14th of December, 1829.

The process of M. Niepce may be understood from the following extracts. Says he :—

"The discovery which I have made, and to which I give the name of heliography, consists in producing spontaneously by the action of light, with gradations of tints from black to white, the images received by the camera obscura. Light in its state of composition and decomposition acts chemically upon bodies. It is absorbed, it combines with them, and communicates to them new properties. Thus it augments the natural consistency of some of these bodies; it solidifies them even, and renders them more or less insoluble, according to the duration or intensity of its action. The substance which has succeeded best with me, and which concurs most immediately to produce the effect, is asphaltum of bitumen of Judea, prepared in the following manner :—I fill about half a wine-glass with this pulverised bitumen. I pour upon it drop by drop the essential oil of lavender, till the bitumen can absorb no more. I afterwards add as much more of the essential oil as will cause the whole to stand about three lines above the mixture, which is then covered and submitted to a gentle heat, until the essential oil is fully impregnated with the colouring matter of the bitumen. If this varnish is not of the required consistency, it is to be allowed to evaporate slowly, without heat, in a shallow dish, care being taken to protect it from moisture, by which it is injured and at last decomposed. A tablet of plated silver is to be highly polished, on which a thin coating of varnish is to be applied cold with a light roll of very soft skin; this will impart to it a fine vermillion colour, and cover it with a very thin and equal coating. The plate is then placed upon heated iron, which is wrapped round with several folds of paper, from which, by this method, all moisture has been previously expelled. When the varnish has ceased to simmer, the plate is withdrawn from the heat, and left to cool and dry in a gentle temperature, and protected from a damp atmosphere. The plate thus prepared may be immediately submitted to the action of the luminous fluid in the focus of the camera, But even, after having been thus exposed a length of time sufficient for receiving impressions of external objects, nothing is apparent to show that these impressions exist. The forms of the future picture remain still invisible. The next operation, then, is to disengage the shrouded imagery, and this is accomplished by a solvent." Into this solvent, which it appears is formed of essential oil of lavender and oil of white petroleum, the silver tablet is plunged, and slowly the picture begins to appear. The plate is then lifted out and held in a vertical position, till as much as possible of the solvent has been allowed to drop away. The pictured tablet is now carefully washed by being placed upon an inclined plane, over which a stream of water is carefully poured.

Still later, we find M. Niepce complaining of the imperfection of his plan, but stating that he now employed iodine in the preparation of his plates. Silvered plates prepared with iodine is the great secret of the photographic art.

In 1839, M. Daguerre made known the result of his experiments. He prepared the silvered plates, brightly polished, by placing them over a box, at the bottom of which there was a little iodine undergoing spontaneous evaporation. Thus prepared by receiving a thin film of the iodine, the plate was exposed to the focus of the camera; there it received the image presented to it: when removed, not a trace of the picture was to be seen, but presented one uniform dark shade without any mark. The plate was then exposed in a second box to an ascending mercurial vapour, heated from below by the action of a spirit-lamp. The effect produced was as curious as it was interesting. The small globules of mercury began immediately to settle upon those parts of the plates which have been effected by the action of the light. Gradually, the higher lights and the half tints were developed. Like a delicate graver, the mercury settled on each part of the plate with the proportionate depth.

When the picture had been fully brought out, the plate was immersed in a solution of hydro-sulphate of soda, and afterwards washed with hot distilled water. At that time no method had been discovered by which the photographic image could be "fixed," and the long period necessary for obtaining an impression upon the prepared plate when in the camera, rendered it useful only in taking views or copying engravings.

From that time to the present wonderful improvements have been made in the process. Formerly hours elapsed before an impression was obtained; now a few seconds suffices to secure an accurate and striking portrait. M. Daguerre made known his discovery to the scientific world of Paris. In July the same year (1839), a bill was passed securing to him a pension for life of 6,000 francs, and to M. Niepce of 4,000 francs. These things are very differently done in France and in England, and inventors and discoverers are not there altogether overlooked. France purchased the secret, and gave it to the whole world; but in spite of the declaration that the invention did not admit of being secured by patent, for as soon as published all might avail themselves of its advantages, royal letters patent were granted for the exclusive use of the same in the United Kingdom. It is unnecessary in this place to comment upon the fact, or detail the law proceedings consequent thereupon.

In the hands of M. Claudet, and other well-known photographers both in England and America, daguerreotype has vastly improved. A degree of sensibility has been given to the plate which it seems almost impossible to surpass. After a coating of iodine has been obtained upon the polished surface of the plate, it is exposed to the influence of chloride of bromine. Fizeau recommends the use of bromine water for the purpose of improving the sensitiveness of the iodized plates. This is prepared by shaking together in a bottle some bromine and water, care being taken that the bromine appears in excess. One part of this bromine liquor is united with thirty or forty parts of water, and being poured into a square shallow vessel covered with a glass, the iodized plate is exposed to its action for a few seconds, during which it passes from a yellow colour into a rose hue, which is generally supposed to be the most sensitive coating.

After having been exposed in the camera, it is not necessary, when placed in the mercurial vapour box, to heat the mercury. Faraday proved that mercury was volatilized at common temperature; and Moser has pointed out that if the daguerreotype plate is placed over a vessel of cold mercury for some hours, the image will be brought out in the same manner as if the mercury had been warmed. Heating the mercury facilitates the process, but must be done with great care.

The chloride of gold has been recommended for the purpose of giving adhesion to the mercurial deposit. After the iodine has been removed from the plate, it is placed upon an iron frame, and a sufficient quantity of the solution of salt of gold poured carefully upon it, so as to entirely cover the surface. It is then heated by a spirit lamp, and the impression at once assumes greater depth and force of tone; the solution is then poured off, the plate well washed with distilled water and thoroughly dried. This process not only improves the general effect of the picture, but renders it also far less liable to injury.

It is not the brightest and clearest sunshine which is most favourable to photographic experiments. In England, the months of March, April, and May, are far more favourable to these operations than June, July, and August. In tropical climes, when a brilliant sun is giving the utmost degree of illumination to all surrounding objects, all photographic operations are acted upon more slowly than in the climate of England, where the light is less intense. As a remarkable instance of this fact, a circumstance may be mentioned which is curiously illustrative of this phenomenon:—A gentleman, well acquainted with the daguerreotype process, took with him to Mexico all the necessary apparatus and chemicals, expecting, under the bright light and cloudless skies of that climate, to produce pictures of superior excellence. Failure upon failure was the result, and although every care was used, and every precaution adopted, it was not until the rainy season set in that he could secure a good daguerreotype of any of the buildings in that far-off land. A similar failure attended the experiments made by order of the French government in Egypt and central America.

The expense and inconvenience of metallic plates, particularly to travellers, renders it desirable that some other material should be employed instead. Attempts were made to obtain photographic effects upon paper, and the experiments were successful. In 1834, Mr. H. Fox Talbot began some researches with a view of rendering the images of the camera obscura permanent. On the 31st of January, 1839, six months prior to the publication of Daguerre's process, a paper, giving an account of Talbot's labours was read before the Royal Society. In February, 1839, the method of preparing photogenic paper was made known.

The following is the method of obtaining pictures by the calotype or talbotype process. A hundred grains of crystallized nitrate of silver should be dissolved in six ounces of distilled water. The paper which is to be employed should be washed on one side with this solution. It must then be allowed to dry. Afterwards it must be dipped into a solution of iodide of potassium, containing five hundred grains of that salt dissolved in one pint of water, and be permitted to remain in this solution two or three minutes. It must then be dipped into a vessel of pure water, and lightly dabbed with blotting paper. This should be done by candle-light. This is called iodized paper. When required for use, a sheet of this iodized paper may be taken and washed with a liquid prepared in the following manner:—Dissolve one hundred grains of crystallized nitrate of silver in two ounces of distilled water add to this one-sixth of acetic acid. Let this mixture be called A. Make a saturated solution of crystallized gallic acid in cold distilled water. The quantity dissolved is very small. Call this solution B. These two solutions are to be mixed together in equal quantities. After the paper has been washed with this liquid, which must not be done in the daylight, it should rest half a minute, and be then dipped into water. It must then be lightly dried with blotting paper. When dry the paper is fit for use. If used immediately, the last drying need not be attended to, the paper being placed damp in the camera.

When the paper is removed from the camera, very little or no trace of a picture is visible, until it has been subjected to the action of a solution of gallic acid and acetic-nitrate of silver, which is applied to the surface of the paper on which the latent image has been formed, the development of the picture being accelerated by the cautious application of heat. It is then washed first in distilled water and afterwards in a solution of hypo-sulphate of soda, for the purpose of removing the nitrate and iodide of silver, and so fixing the picture that it may undergo no further change when exposed to the light. It is lastly dried between folds of blotting paper.

The picture thus obtained, is, however, a negative impression, that is, the positions of the objects, together with the lights and shades, are totally reversed with respect to their real appearance. In order to obtain the positive or correct representation, the negative picture is laid perfectly flat and smooth on paper prepared with muriate of baryta and nitrate of silver, and then being placed in the reversing frame, or between two pieces of glass and exposed to the light, the correct impression is produced.

We shall revert to this subject on another occasion.